we rode easily over a smooth wave. Against the rocky promontory which protects the landing-stage the water surged up violently, then subsided 3 or 4 feet, and surged up again more than once. We now put in behind the shelter of this promontory. At 7.15 p.m. the bore was 300 yards past the ferry, having travelled 3¼ miles, or a little more, in thirty minutes. It was due at the ferry, according to the tide-table, at 7.17 p.m. At 7.21 a steady torrent of water was pouring past the promontory. At 7.29 the torrent was roaring, and the standing waves appeared to be 3 feet high. At 7.44 the waves were smoothed out; the current appeared to be quite as swift, but the greatly increased depth diminishes the surface effect of the rough bottom. The boatmen tell me that the current was "logged" when a bridge was in contemplation, a velocity of 11 knots being registered. Owing to dark clouds and a lurid sunset, I took no photographs. After the passing of the bore there was half an hour's gossip at the ferry, with reminiscences of many bores.

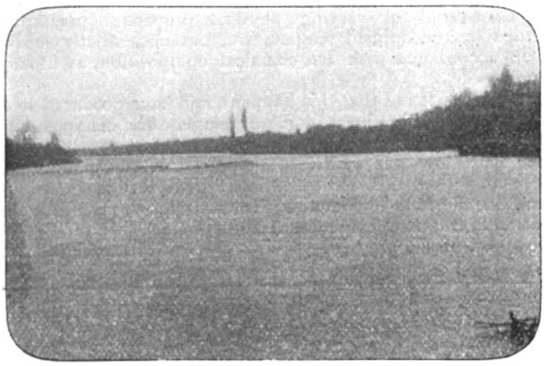

FIG. 1.—The Bore approaching.

Next morning, April 30, I got into the dog-cart at 7.30 a.m., and drove 6¼ miles, much of the way through plum orchards in full blossom, to Denny, 9¼ miles by river above Newnham Ferry. Owing to the difference of distance by road and river, it is possible to see the same bore at both places by cycling or driving; but I required spare time to arrange for photography. The clouds were heavy and a little fine rain fell at times, hence the necessarily instantaneous photographs are not as bright as they should be for successful reproduction. The spot for observation is a cottage garden by the Denny Brook. The river here is little more than 50 yards wide, flowing between steep banks, slime-covered between tide marks, with no sandy shoals. The bore appeared at 8.47 a.m., and disappeared round a bend at 8.53 a.m. Taking its time at Newnham Ferry from the tide-table, this gives 70 minutes for time of traversing 9¼ miles, or close on 8 miles an hour. The speed below Newnham was one mile per hour less than this. I guessed the height of the bore at 3 feet in the deep water, 4 feet where bursting on the outer bank. The broken water flew higher than this. These, however, are not trustworthy estimates, as I was busy photographing, obtaining seven exposures in all. Fig. 1 was taken as the bore approached; in Fig. 2 it is seen in passing, showing the wave-surface at back of the bore itself. When in the boat at Newnham I recorded the same thing as a rising and falling of the water against the bank. High water was reached about 9.40 a.m. The current continued to flow up stream; at 10 a.m. it was slack on the concave (western) shore, but still flowing in mid-stream; at 10.18 a.m. it was distinctly running down even in midstream, the water-level having already fallen nearly 3 feet. From the arrival of the bore to the complete turn of the current may be taken to be 1¼ hours.

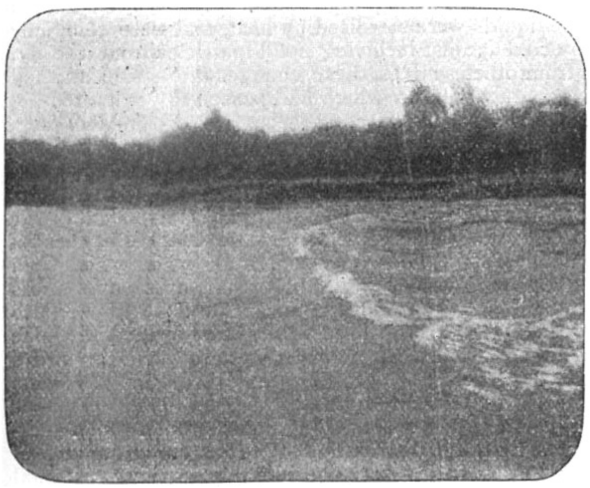

FIG. 2.—Wave Surface at Back of Bore.

Ordinary photographs show the form of a bore, but its character does not lie so much in its form as in its motion, which combines the mysterious, ghost-like movement of a wave with the rushing steadiness of a railway train. I hope the phenomenon may soon be cinematographed.

1, Savile Row, W. VAUGHAN CORNISH.

Bamboo Manna.

THE recent occurrence of a sweet secretion on the stems of bamboos growing in the Central Provinces is a most interesting fact to students of antiquarian medicine. Bamboo manna derives its name from the Sanskrit words—Tvak-kshira, "bark milk"; Vansa-sarkara, "bamboo sugar"; and Vanśa-karpura, "bamboo camphor." Vansa-lochana is the name by which it is known by Indian physicians at the present day. These terms would signify a manna-like substance exuding from the stem of the tree, but what is known and used as Vansa-lochana all over India is quite a different article.

That bamboo manna is not a sugar, but a white, gritty body, now called Tabashir by Europeans, is gathered from the account of Dioscorides, and from the fact that no kind of sugar prepared from the sugar cane answering to this description was known in India in his time. Dioscorides writes: "What is called σάκχαρον is a kind of concrete honey, found in reeds in India and Arabia Felix, in consistence like salt, and brittle between the teeth like salt." Tabáshir, or bamboo manna, was known to the early Arab travellers in the East, and the port of Thana, on the western coast of India, was famous for this product in the twelfth century. Tabáshir is employed as a medicine for its cooling, tonic, aphrodisiac and pectoral properties. In its crude state, when taken from the inside of the bamboo stems, it is mixed with insect remains, and has a blackish appearance; but on gently calcining it becomes quite white, with a pearly lustre. It consists of about 80 per cent. of pure silica, with variable proportions of alkalis, water and organic matter. The history and properties of tabáshir have been very fully discussed by Sir David Brewster (*Philos. Trans.* 1819; *Edin. Journ. Science*, vol. viii. p. 286); Sir George Birdwood (*Bombay Products*, pp. 95-96); Dr. F. A. Flückiger (*Zeit. des Allg. Osterr. Apoth. Ver.* 1887, No. 14), and by Sir D. Brandis (*Indian Forester*, March 1887).

The only modern work which alludes to a sugar in the bamboo is the "System of Botany," by La Maout and Decaisne. The authors remark:—"The young shoots of these two trees (*Bambusa arundinacea* and *B. verticellata*) contain a sugary pith which the Indians seek eagerly; when they have acquired more solidity, a liquid flows spontaneously from their nodes, and is converted by the action of the sun into drops of true sugar. The internodes of the stem often contain silicious concretions, of an opaline nature, named tabáshir." Here a distinction is made between the manna forming on the outside of the stem and the tabáshir found inside, but no reference is made to any record where the first named exudation was observed or examined. Dr Watt, when writing the article on Bambusa for his "Dictionary of Economic Products of India," sums up the general experience with regard to this point, and says: "nor has the spontaneous excretion of sugar on the outside of the stem ever been recorded by Indian travellers."

The strange appearance of manna on the stems of the bamboo was reported last March by the Divisional Forest Officer, Chanda, Central Provinces, and notices of this phenomenon have been published in the local papers. The bamboo forests of Chanda consist of *Dendrocalamus strictus*, the male bamboo, a bushy plant from 20 to 30 feet in height, and affecting the cooler northerly and westerly slopes of Central and Southern India. This is said to be the first time in the history of these forests that a sweet and gummy substance has been known to exude from the trees. The gum has been exuding in some abundance, and it has been found very palatable to the natives in the neighbourhood, who have been consuming it as a food. The occurrence of the manna at this season is all the more remarkable, since the greatest famine India has known is this year visiting the country, and the districts where the scarcity is most keenly felt are in the Central Provinces.

An authentic specimen of this bamboo manna was sent to Dr. Watt, Reporter on Economic Products, Calcutta, and was subsequently handed to me for examination. It occurred in short stalactiform rods about an inch long, white or light brown in colour, more or less cylindrical in shape, but flattened or grooved on one side where the tear had adhered to the stem. It was pleasantly sweet, without the peculiar mawkish taste of Sicilian manna (*Fraxinus rotundifolia*). It was soluble in less than its own weight of water, and the solution when allowed to repose deposited white, transparent crystals of sugar. The manna contained 2·66 per cent. of moisture, 0·96 per cent. of ash, 0·75 per cent. of a substance reducing Fehling solution, and a small quantity of nitrogenous matter. The remainder consisted of a sugar which became inverted in twenty minutes when boiled with dilute hydrochloric acid (1 per cent.), and from its solubility, melting-point and crystalline nature, appeared to be a saccharose, related to, if not identical with, cane sugar. It contained no mannite, the saccharine principle peculiar to true manna.

The bamboos and sugar canes belong to the same natural order of grasses, and perhaps it is not unnatural to expect them to yield a similar sweet substance which can be used as a food; but it is a coincidence that the culms of the bamboo, hitherto regarded as dry and barren, should in a time of great scarcity afford sustenance for a famine-stricken people.

Indian Museum, Calcutta, May 3. DAVID HOOPER.

Solution Theory Applied to Molten Iron and Steel.

I AM pleased to notice that the theory of solution of iron and steel has recently received attention, and that valuable work has been placed before us for consideration by Baron von Juptner (see recent proceedings of the Iron and Steel Institute).

Will you, however, permit me to state that many years ago, in a contribution to the Institute (*Iron and Steel Inst.* 1881), I advocated the theory of solution in the following words:—

"The solution theory is directly applicable to fluid iron and steel, as it is to water. Carbon, phosphorus, &c., are more or less soluble in the fluid metal, just as salts are soluble in water; in both cases the same forces are at work; water, however, at the normal temperature of 60° Fahr., fluid iron about 2500°–3500° Fahr."

"Further, the physical or gaseous theory of solution best explains the facts; the so-called chemical theory of solution is not so applicable. It is difficult to give satisfactory reasons for the union of stable bodies such as carbon and iron, but the gaseous theory of solution apparently does so.

"The difficulty of its complete or further application becomes one of degree only, for no definite distinction can be drawn between gases, liquids and solids, more especially when the latter are heated.

"The quantity of matter dissolved in a given time is simply a function of temperature, and at low osmotic pressure is comparable with that of a liquid evaporating under the pressure of its own vapour" (NATURE, 1892).

"Moreover, it is remarked that ordinary soft steels for sheets, rails, &c., should be so manipulated as to produce a colloid, or, as near as possible, a non-crystalline material, avoiding always the formation of large crystals" (*Iron and Steel Inst.* 1881).

In my practice I have always adhered to the solution theory, finding that it gave the key to the solution of many discrepancies observed in the manufacture of steel, which ordinary analysis, and the usual theoretical deductions therefrom, sometimes failed to explain.

It appears to me, however, that the solution theory requires extension. We have, I think, up to the present only touched upon the surface of the matter, and more extended and deeper research will amply repay those who have already done work in this direction.

In connection with this subject, although perhaps not exactly bearing upon it, there is what may be termed the theory of the crystallisation of steel and iron. A sheet of ice, as is well known, shows, when heated, beautiful structural, or more correctly crystalline, changes. Why should not a steel plate exhibit changes of this kind if similarly treated?

It is evident, as has been remarked of others, that if the sheet of either ice or iron be suddenly cooled at a given temperature, the structure or grain at that temperature will be approximately retained, and that steel of a given chemical composition may give a material of varying physical properties practically governed by the applied temperature, but not, strictly speaking, in accordance with its chemical composition, as usually assumed.

I have lately found that this happens, and have produced steel of four degrees of hardness by mere temperature manipulation, with metal containing only one-tenth per cent. of carbon together with low per cents. of sulphur and phosphorus. I believe also that this has been done to a certain extent by others, but the facts have not, so far as I know, met with the attention of the practical manufacturers of steel.

Newport, Mon., May 16. JOHN PARRY.

THE BACTERIAL TREATMENT OF SEWAGE.

THE discovery made by Schwann, in 1839, that a putrefying liquid swarmed with microscopic living organisms, gave occasion to a long series of remarkable investigations as to the general nature and the life-history of these organisms, and the chemical changes which they produced.

Prominent amongst the names of those who prosecuted these investigations stands that of Pasteur, who, in 1857, drew attention to the nature and causes of fermentative changes produced upon sugar solution, of the putrefactive changes in liquids containing animal substances, and of disease changes in the blood of the living animal, which were produced in the presence of various minute living organisms. He showed that, if these liquids were sterilised by heat, and were then duly protected against receiving solid particles from the air, or from other sources, these changes did not occur; and that contact with air which had passed through a red-hot tube, or had been filtered through a cotton-wool plug, was incompetent to introduce the organisms and to start the above changes.

These researches drew attention to the important part played by the air as a vehicle of the organisms or of their spores, and was supplemented by the researches of Tyndall (1876), who proved that air which had been allowed to remain at rest until its motes had subsided was incompetent to produce putrefaction. Tyndall also proved that boiled sterilised broth, when opened in Alpine air, did not usually putrefy, and that the air near the earth's surface in different localities, and even in the same locality at different times, possessed infective power varying from nil to something considerable. The inference is that the distribution of these organisms and of their spores varies very considerably in any horizontal plane near the earth's surface.

Percy Frankland (1886) determined the number of these living organisms which could be developed from equal volumes of air collected at varying heights from the earth's surface. He made use of hills and cathedral towers for the purpose of collecting his samples, and noted a regular decrease in the number of the organisms which were in the air at greater and greater distances from the earth's surface.

These typical researches render it evident that the organisms and their spores, which are produced at or near the earth's surface, are wafted by natural atmospheric movements to some height, but are constantly